

PCTWORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : C02F 1/46, A61L 2/18, C23F 11/00	A1	(11) International Publication Number: WO 99/28238 (43) International Publication Date: 10 June 1999 (10.06.99)
<p>(21) International Application Number: PCT/US98/25100</p> <p>(22) International Filing Date: 1 December 1998 (01.12.98)</p> <p>(30) Priority Data: 08/984,752 4 December 1997 (04.12.97) US</p> <p>(71) Applicant: STERIS CORPORATION [US/US]; 5960 Heisley Road, Mentor, OH 44060 (US).</p> <p>(72) Inventors: MALCHESKY, Paul, S.; 239 Barrington Ridge, Painesville Twp., OH 44077 (US). FRICKER, Christopher, M.; 7960 Fieldstone Court, Concord, OH 44060 (US).</p> <p>(74) Agent: KOCOVSKY, Thomas, E., Jr.; Fay, Sharpe, Beall, Fagan, Minnich & McKee, Suite 700, 1100 Superior Avenue, Cleveland, OH 44114-2518 (US).</p>		<p>(81) Designated States: AU, BR, CA, CN, IL, JP, KR, MX, SG, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).</p> <p>Published <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i></p>
<p>(54) Title: CHEMICAL MODIFICATION OF ELECTROCHEMICALLY ACTIVATED WATER</p> <p>(57) Abstract</p> <p>An anticorrosive, penetration enhancing composition for cleaning decontaminating and rinsing includes electrochemically activated (ECA) water as the decontamination agent. The anticorrosive decontamination composition has, as the anticorrosive agent, a compound or mixture of compounds capable of inhibiting corrosion of various metals used in sterilization decontamination and rinsing systems and objects such as medical instruments. Preferred anticorrosive compounds include phosphates, azoles, and sulfates. Other additives, including wetting agents, are added to reduce the surface energy of the ECA water. This reduced surface energy permits the ECA water to penetrate into objects of complex design thus permitting complete decontamination of the treated object.</p>		

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece			TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon			PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakhstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

CHEMICAL MODIFICATION OF ELECTROCHEMICALLY ACTIVATED WATER

Field of the Invention

The present invention relates to the decontamination and cleaning arts. It finds particular application in conjunction with the decontamination of medical instruments and equipment. It will be appreciated, however, that the invention is also applicable to the microbial decontamination, including disinfection or sterilization, of other articles such as food processing equipment, pharmaceutical processing equipment, animal cages, and other equipment.

Background of the Invention

Various methods and apparatus are known for decontaminating and/or sterilizing medical instruments and devices. For example, medical instruments and other devices are commonly sterilized in a steam autoclave. Autoclaves kill life forms with a combination of high temperature and high pressure. However, steam autoclaves have several drawbacks. The pressure vessels are bulky and heavy. Also, the high temperature and pressure tend to reduce the useful life of medical devices having rubber and plastic components. The medical devices must be pre-cleaned before being placed in the autoclave to remove bodily tissues and fluids. Moreover, the autoclave sterilization and cool-down cycles take an excessive amount of time, especially in light of the need to minimize the "down time" of expensive, reusable medical devices.

Another known sterilization method utilizes ethylene oxide gas. Ethylene oxide gas sterilization and aeration cycles are even longer than steam autoclave sterilization and cool-down cycles. Ethylene oxide is

- 2 -

also hazardous to humans and, therefore, environmental concerns are associated with its use.

Low temperature liquid disinfection and sterilization devices are also known. These devices typically utilize one of several known liquid antimicrobial solutions such as peracetic acid, glutaraldehyde, alcohol, aqueous hydrogen peroxide, and the like. In general, these low temperature liquid systems have been found to be effective. However, hospitals and other health care facilities continue to demand improved sterilization effectiveness and efficiency to reduce the risk of infection and to reduce the percentage of time that expensive medical devices are out of use for sterilization procedures. Also, certain low temperature liquid anti-microbial solutions have fallen out of favor. For example, the use of glutaraldehyde presents environmental concerns and also requires an excessively long cycle time to sterilize, rather than simply disinfect, medical devices. The environmentally harmful glutaraldehyde must be specially disposed of, increasing the cost of sterilization. Other agents, such as alcohols, have been found to be destructive to certain plastic components of medical instruments.

Recently, there has been an increased emphasis on the effective cleaning of post-operative debris from the medical instruments and devices. Most known sterilization equipment require that the contaminated medical devices be precleaned before the sterilization cycle. Others simply sterilize without regard to cleaning which results in a sterile device having sterile debris adhered thereto.

Certain sterilization devices rely upon the filtering of water with a 0.2 μ m or smaller pore size microbe-removal filter media to provide a sterile rinse liquid. However, it would be desirable to provide an additional safeguard against the recontamination of medical devices with rinse liquid by ensuring a virus-free

- 3 -

rinse solution. A virus-free rinse solution may not be assured with simple filtration of the rinse liquid. Therefore, there has been found a need to provide a sterilization apparatus that ensures a bacteria and virus free rinse liquid to prevent the accidental recontamination of the sterilized medical device during rinsing operations.

Most recently, the cleaning and decontamination properties of solutions formed via the electrolysis of water under special conditions have been explored. Electrolysis devices are known which receive a supply of water, such as tap water, commonly doped with a salt, and perform electrolysis on the water to produce (I) an anolyte produced at the anode of the electrolysis unit; and, (ii) and catholyte produced at the cathode of the electrolysis unit. The anolyte and catholyte may be used individually or as a combination. The anolyte has been found to have anti-microbial properties, including anti-viral properties. The catholyte has been found to have cleaning properties.

To create these anolyte and catholyte solutions, tap water, often with an added electrically conducting agent such as halogen salts including the salts sodium chloride and potassium chloride, is passed through an electrolysis unit or module which has at least one anode chamber and at least one cathode chamber which may be separated from each other by a membrane. An anode contacts the water flowing in the anode chamber, while the cathode contacts the water flowing in the cathode chamber. The anode and cathode are connected across a source of electrical potential to expose the water to an electrical field. The membrane may allow the transfer of electron carrying species between the anode and the cathode but limits fluid transfer between the anode and cathode chambers. The salt and minerals naturally present in and/or added to the tap water undergo oxidation in the anode chamber and reduction in the cathode chamber. The

- 4 -

solution resulting at the anode (anolyte) and the solution resulting at the cathode (catholyte) remain separate or are recombined and can be used for a wide variety of different purposes.

5 However, electrochemically activated (ECA) water is not without shortcomings. ECA waters have high surface energies comparable to the incoming water. The high surface energies of ECA water have been found to cause lower penetration ability of the ECA water. In the
10 medical instrument field, for example, high penetration ability is desired due to the complex nature of medical instruments. A sterilant must be able to penetrate even the smallest crevices in order to ensure the sterility of the instrument. The high surface energy of ECA water does
15 not allow for penetration of the ECA water into creviced areas of medical instruments. Thus, complete kill may not be achieved.

 Further problems have arisen on metal surfaces coming into contact with the ECA water, including the
20 sterilization equipment and metal medical devices. The ECA water is corrosive to metal. Stainless steel, used to produce many medical devices, is particularly susceptible to corrosion by ECA water.

 ECA water as a decontamination and cleaning
25 agent can therefore produce some results which are problematic when decontaminating complex metal objects such as stainless steel medical equipment.

 The present invention contemplates an improved ECA water solution. The improved ECA water solution has
30 enhanced penetration ability and reduced corrosiveness compared to prior ECA water solutions.

Summary of the Invention

 In accordance with the present invention, an electrochemically activated (ECA) water decontamination
35 composition is provided which comprises electrochemically activated (ECA) water as the decontamination agent. The

- 5 -

composition further includes at least one of a corrosion inhibitor, a wetting agents and a combination thereof.

In accordance with another aspect of the invention, a method of decontaminating medical instruments 5 is provided. The instruments are contacted with ECA water including at least one of a corrosion inhibitor and a wetting agent.

In accordance with a further aspect of the invention, a method for decontamination uses ECA water 10 with at least one of a corrosion inhibitor, a wetting agent, and combinations thereof to decontaminate articles or systems.

One advantage of the present composition is that metal objects may be effectively decontaminated using ECA 15 water with considerably reduced metal corrosion.

Another advantage of the present invention resides in its improved solution penetration into complex objects due to lower surface energy of the solution.

A further advantage relates to the use of the 20 treated ECA water as a final rinse solution in a sterilization apparatus without corroding the sterilization apparatus or instruments being sterilized therein.

Still other advantages and benefits of the 25 invention will become apparent to those skilled in the art upon a reading and understanding of the following detailed description of the preferred embodiments.

Detailed Description of the Preferred Embodiments

Water to be used in a sterilization procedure is 30 introduced into a suitable water electrolysis apparatus. Such an apparatus includes at least one electrolysis unit or module having an anode chamber and a cathode chamber and may be separated by a membrane. The membrane, if present, divides the water into two parts, a first part in 35 the anode chamber and a second part in the cathode chamber. In flow through systems, incoming water is

divided into two flows that are channeled to the anode and cathode chambers, respectively. Examples of such water electrolysis units are as described in U.S. Patent Nos. 5,635,040; 5,628,888; 5,427,667; 5,334,383; 5,507,932; 5,560,816; and 5,622,848. Any other suitable water electrolysis units may be used, including an electrolysis unit that utilizes a batch type electrochemical activation. The invention is not meant to be limited to any particular electrolysis apparatus.

10 The electrode chamber of an electrolysis unit includes an anode electrode and a cathode electrode that contacts the passing water. The membrane, if present, prevents the anolyte and catholyte from mixing. The membrane allows electron carrying species to transfer
15 between the anode and cathode chambers. A source of electric potential is connected across the anode and the cathode to expose the water to an electric field that produces an oxidation reaction at the anode and a reduction reaction at the cathode. These reactions
20 convert the water into an anolyte solution and a catholyte solution. If desired, first and second reservoirs or holding tanks may be provided in fluid communication with the outlets of the chambers in a system separating the anolyte and catholyte to hold the catholyte and anolyte
25 solutions, respectively, as they are produced so that these solutions may be used subsequently for decontamination and/or cleaning, including disinfection, sterilization, and rinsing operations.

 In a first embodiment, corrosion inhibiting and
30 surface energy reducing additives are introduced into the water prior to electrolysis. In a second embodiment, the additives are added after electrolysis. If added after electrolysis, the additives may be added to the catholyte or the anolyte. Other additives, including, but not
35 limited to, detergents and pH buffers, may also be added to the catholyte and/or anolyte solution. —

- 7 -

The corrosion inhibitory agents are selected in accordance with the nature of the materials in the items being cleaned and/or decontaminated with the electrochemically activated water. Corrosion inhibitors which protect against corrosion of aluminum and steel, including stainless steel, include phosphates, sulfates, chromates, dichromates, borates, molybdates, vanadates, and tungstates. Some additional aluminum corrosion inhibitors include 8-hydroxyquinoline and ortho-phenylphenol.

More specifically, phosphates are preferred for inhibiting stainless steel corrosion. Preferred phosphates include, but are not limited to, monosodium phosphate (MSP), disodium phosphate (DSP), sodium tripolyphosphate (TSP), sodium hexametaphosphate (HMP), and sodium sulfate either alone or in combination. Preferred borates include sodium metaborate (NaBO_2).

The copper and brass corrosion inhibitors include triazoles, azoles, benzoates, tolyltriazoles, dimercapto-thiadiazoles, and other five-membered ring compounds. Preferably, the copper and brass corrosion inhibitors include sodium salts of benzotriazole and tolyltriazole which are preferred due to their stability in the presence of strong oxidizing compounds. Mercaptobenzothiazole can also be utilized but is apt to be oxidized or destabilized by strong oxidizers. Salicylic acid is an example of an acceptable benzoate corrosion inhibitor.

In hard water, the phosphates tend to cause calcium and magnesium salts present in hard water to precipitate and coat the instruments being decontaminated and/or cleaned and also leaves deposits on parts of the electrolysis system. A sequestering agent appropriate to prevent precipitation such as sodium hexametaphosphate (HMP), or trisodium nitrolotri-acetic acid (NTA Na_3) is preferably provided. Because sodium hexametaphosphate is also a corrosion inhibitor, it serves a dual purpose, both

- 8 -

as a corrosion inhibitor and as a sequestering agent. Other sequestering agents include sodium polyacrylates. Of course, if soft or deionized water is utilized, the sequestering agent may be eliminated. However, to ensure
5 universal applicability with any water that might be utilized, the presence of a sequestering agent is preferred.

A surface energy reducing agent is added to the electrochemically activated water in order to reduce the
10 surface energy of electrochemically activated water thereby increasing the ability of the electrochemically activated water to penetrate into crevices of items being treated. This is particularly important when cleaning and decontaminating complex medical instruments which may
15 contain microbial contaminants in crevices, joints, and lumens.

Surface energy reducing agents usable in accordance with the present invention include various wetting agents. Such wetting agents include anionic,
20 cationic, nonionic, amphoteric, and/or zwitterionic surfactants. Specific classes of wetting agents which useful include anionic and nonionic surfactants or combinations thereof. Examples of nonionic wetting agents usable in the present invention include surfactants such
25 as fatty alcohol polyglycol ethers, nonylphenoxypoly (ethyleneoxy) ethanol, and ethoxylated polyoxypropylene. Specific examples include Genapol UD-50™, Igepal™ Fluowet™ and Pegal™. The wetting agents set forth above may be used alone or in combination with each other.

30 In a first embodiment, corrosion inhibitors such as monosodium phosphate, disodium phosphate, and sodium hexametaphosphate, either alone or in combination, are added to water along with a wetting agent prior to electrochemical activation. The above treated water is
35 especially useful as a decontamination and/or cleaning agent for stainless steel medical instruments—wherein the treated instrument remains free of corrosion but is

- 9 -

microbially decontaminated. In addition, the above treated water is highly effective as a rinsing agent for use in conventional sterilization systems. The ECA water acts not only as a rinse but as an antimicrobial protective rinse. By adding the corrosion inhibitors and wetting agents, the sterilization system and instruments are protected from corrosion and decontamination from the rinse solution.

A second embodiment introduces the corrosion inhibitors and/or wetting agents to the catholyte or anolyte produced after electrolysis of the water. The same advantages described above remain readily realized.

Amounts of corrosion inhibitor and wetting agents to be added to the electrochemically activated water will vary depending upon the type of agent being added and whether or not one or more agents are added.

The inorganic corrosion inhibitors are preferably present in amounts ranging from about 0.01% to 20.0% weight per volume (w/v). Organic corrosion inhibitors are preferably present in amounts ranging from about 0.01% to 5.0% w/v. Phosphates are preferably effective at rates in the range of about 0.01% to about 11.0% w/v.

The wetting agents are preferably present in amounts ranging from about 0.0001% to about 5.0% w/v. More preferably, the wetting agent is present in amounts ranging from about 0.0001% to about 0.5% w/v.

FORMULATION EXAMPLE

An example of a formulation according to the invention is set forth below:

Formulation 1:

- Component 1) Disodium phosphate (DSP) 4.766 g/L (corrosion inhibitor)
- Component 2) Monosodium phosphate (MSP) 0.40 g/L (corrosion inhibitor)
- Component 3) Sodium hexametaphosphate (HMP) 0.330 g/L (corrosion inhibitor)
- Component 4) Genapol 462 μ l/L (wetting agent)

- 10 -

The following are examples that illustrate the corrosion inhibiting effectiveness, anti-microbial, and surface tension reducing properties of the compositions of the present invention.

5 The examples below all utilize the composition identified hereinbefore as **Formulation 1**. Additionally, the ECA solution was prepared according to the method described hereinbefore.

Surface Tension Reduction

10 Surface tension of ECA solutions without additives vs. surface tension of ECA solutions with additives (Formulation 1) are given in Table 1:

Table 1

	ECA Solutions Without Additives	ECA Solutions With Additives
15 Surface Tension (dynes/cm)	69.9, 64.1, 72.8	28.7, 28.6, 28.0, 28.3, 28.4

Note: The surface tension of deionized water at 25°C is 72.8 dynes/cm.

As can be seen, when using the formulation of the invention with ECA water, surface tension decreased to
20 less than half of the amount present in an untreated ECA solution.

Antimicrobial Properties

D-value comparison for ECA solution without additives vs. ECA solution with additives (Formulation 1) are given in Table 2:

5

Table 2

Test Solution	Temp., °C	n	Avg. linear reg. D-value (sec)	Longest endpoint (sec)	Test organism
ECA	20	7	28.4±6.6	240	<i>B. subtilis</i>
ECA w/ Formulation 1	20	1	33.0	210	<i>B. subtilis</i>

10 n = number of tests

As is evident from the above comparison, the additives do not adversely affect the antimicrobial properties of the ECA water.

Corrosion Inhibitory Properties

15

The data in Table 3 compares the corrosion occurring on materials exposed to ECA water (without additives) and a bleach solution. Both the ECA water and bleach solution have ~300 ppm free chlorine. As can be seen from the results, metallic materials show a more
20 significant degree of degradation than polymeric materials.

Table 3: Materials Compatibility in Electrochemically Active Solution and Bleach Solution
 The following materials were tested in a bleach use dilution (-300 ppm.). One hour of solution and bleach is equivalent to 1 cycle.

MATERIAL	ECA SOLUTION		BLEACH SOLUTION	
	Cycles	Observations	Cycles	Observations
Aluminum 6061-T6	24	-70% surface discoloration	24	-70% surface discoloration
Anodized Aluminum 6061-T6	720	no change	672	75-80% anodization degraded
Aluminum 1100 (Calgon Vestal)	24	-50% surface discoloration	24	-70% surface discoloration
Anodized Aluminum 1100 (Calgon Vestal)	672	no change	672	75-80% anodization degraded
Brass	24	-50% surface discoloration	24	-70% surface discoloration
Borosilicate	720	no change	600	no change
CDA 110 (Calgon Vestal; 99.9% copper)	24	-50% surface discoloration	24	-50% surface discoloration
CDA 443 (Calgon Vestal; 71% copper, 28% zinc)	24	-50% surface discoloration	24	-50% surface discoloration
Ethylene propylene	720	no change	600	no change
Ethylene propylene diamine (EPDM)	720	no change	600	no change
Fluorosilicone (Viton O-ring)	720	no change	600	no change
Latex (medical glove)	600	little elasticity	600	elasticity in tact, material "bleached" to white color
Polycarbonate	720	no change	600	no change
Polyethylene (high density)	720	no change	600	no change
Polytetrafluoroethylene (Gore-tex tubing)	600	no change	600	no change
Polypropylene	720	no change	600	no change
Polyurethane	48	white label slightly discolored; tackiness	600	no change
			N/A	N/A

MATERIAL	Cycles	ECA SOLUTION Observations	Cycles	BLEACH SOLUTION Observations
Polyvinyl chloride (Tygon tubing)	720	no change	600	no change
Polyvinyl chloride (Tygon tubing-medical grade)	720	no change	600	no change
Polyvinyl chloride (UPVC)	720	no change	600	no change
Silicone (O-ring)	720	cracking	600	cracking
Stainless Steel 17-4P11	24	<5% surface discoloration; pitting (-3 mm. diam.)	24	<5% surface discoloration; pitting (-3 mm. diam.)
Stainless Steel 316L	24	<10% surface discoloration	24	<2% surface discoloration; pitting (-2 mm diam.)
Stainless Steel 316 (Calgon Vestal)	24	<10% surface discoloration	24	<2% surface discoloration; pitting (-2 mm diam.)

- 13 -

The data in Table 4 demonstrates the ability of the additives of the invention, such as Formulation 1 above, to reduce corrosion attributed to untreated ECA water.

TABLE 4: ECA SOLUTION MATERIALS COMPATIBILITY SUMMARY

The following materials were tested in ECA solution, Formulation #1, and in a bleach use dilution (~300 ppm). One hour of solution exposure is equivalent to one cycle. All solutions had a 300 ± 30 ppm free chlorine concentration, which were evaluated spectrophotometrically.

	* BLEACH USE DILUTION	* ECA SOLUTION	* FORMULA #1
Aluminum 6061	@ 24 cycles: ~70% surface discoloration	@ 24 cycles: ~70% surface discoloration	@ 24 cycles: ~5% surface corrosion
Aluminum 6061 - anodized	@ 672 cycles: ~75-80% anodization degraded	no change	no change
Brass	@ 24 cycles: ~70% surface discoloration	@ 24 cycles: ~50% surface discoloration	@ 24 cycles: ~10% surface discoloration
Stainless Steel 316L	@ 24 cycles: <2% surface corrosion; pitting in small area (~3mm diam.)	@ 24 cycles: ~10% surface discoloration	@ 24 cycles: ~5% surface discoloration
Stainless Steel 17-4PH	@ 24 cycles: <5% surface corrosion; pitting in small area (~3mm diam.)	@ 24 cycles: ~5% surface corrosion; pitting in small area (~3mm diam.)	@ 24 cycles: ~2% surface discoloration

* - All solutions had a 300 ± 30 ppm free chlorine concentration, which were evaluated spectrophotometrically.

- 15 -

As can be seen from Table 4, ECA with Formulation #1 additives substantially reduced corrosion in comparison to untreated ECA and a bleach solution on aluminum, brass, and stainless steel. As noted 5 hereinbefore, these are the main metals used in medical equipment.

An additional test was conducted which compared untreated ECA water with ECA water having Formulation #1 added on PENTAX® medical device components. Below, in 10 Table 5, is a comparative analysis of the results.

As can be seen from Table 5, those components of PENTAX medical equipment which were susceptible to corrosion due to ECA water were either not corroded when Formulation #1 was added or the corrosion was 15 substantially reduced in the presence of the additives.

TABLE 5: MATERIALS COMPATIBILITY OF PENTAX MEDICAL DEVICE COMPONENTS IN ELECTROCHEMICALLY ACTIVE SOLUTION OR FORMULA #1

The following materials were tested in ECA Solution with additives, Formula #1 in ECA solution. One hour of solution exposure is equivalent to one cycle.

MATERIAL	ECA SOLUTION		ECA FORMULA #1 SOLUTION	
	Cycles	Observations	Cycles	Observations
Black, plastic cyclinder	120	no change	120	no change
Thin, black collar	120	no change	120	no change
Treated metal tube	8	black "spacks" - qty increases with time; possible inner corrosion	120	no change
Screw w/wide threads	1-120	40% surface corrosion at 120 cycles	120	no change
Screw w/narrow threads	72	<1% corrosion	120	no change
Thin metal piece w/1 hole	120	no change	120	no change
Thin bent metal piece w/4 holes	120	no change	120	no change
Metal nut	1-120	corrosion at 15 minutes; increased corrosion over time; possible leeching of metal-metal binding adhesive	8-120	corrosion at 24 hrs.; increased corrosion over time; possible leeching of metal-metal binding adhesive
Air/water valve			120	no change
Metal inlet/outlet port	1-120	corrosion at 1 hr.; increased corrosion over time; all corrosion appears at soldered joints/pieces	120	no change
Black, metal sleeve w/threads			120	no change

- 17 -

Based on the above comparative tests, the advantages of reduced corrosion and enhanced penetration attained from using ECA water with the above-described corrosion inhibitors and/or surface tension reducing agents are readily apparent wherein the treated ECA water can be utilized without any loss in its biocidal properties.

- 18 -

Having thus described the preferred embodiment, the invention is now claimed to be:

1. An electrochemically activated (ECA) water decontamination composition having electrochemically activated (ECA) water as a decontamination agent characterized by the composition including at least one of
5 a corrosion inhibitor, wetting agent, and a combination thereof.
2. The composition of claim 1 further characterized by the corrosion inhibitor being a copper, brass, aluminum, carbon steel, or stainless steel corrosion inhibitor.
3. The composition of either one of claims 1 and 2 further characterized by the corrosion inhibitor being selected from the group consisting of phosphates, sulfates, molybdates, chromates, dichromates, tungstates,
5 vanadates, borates, benzotriazoles, tolyltriazoles, azoles, benzoates, 8-hydroxyquinoline, ortho-phenylphenol, and combinations thereof.
4. The composition of either one of claims 1 and 2 further characterized by the corrosion inhibitor being a phosphate stainless steel corrosion inhibitor.
5. The composition of claim 4 further characterized by the phosphate stainless steel corrosion inhibitor being selected from the group consisting of monosodium phosphate, disodium phosphate, sodium tripolyphosphate,
5 sodium hexametaphosphate, benzotriazole, tolyltriazole, sebacic acid, and azoleic acid, or a combination thereof.
6. The composition of any one of claims 1-5 further characterized by the wetting agent being selected from the

- 19 -

group consisting of nonionic and anionic wetting agents and combinations thereof.

7. The composition of any one of claims 1-6 wherein the wetting agent is selected from fatty alcohol, polyglycol ethers, nonylphenoxypoly(ethyleneoxy) ethanol, and ethoxylated polyoxypropylene or combinations thereof.

8. The composition of any one of claims 1-7 further characterized by:

the composition providing for the penetration of the ECA water into items coming in contact with said ECA
5 water;

the ECA water not corroding any copper, brass, aluminum, carbon steel, or stainless steel surfaces with which it comes in contact.

9. The composition of claims 1-8 further characterized by the corrosion inhibiting agent being present in the range of about 0.01% to about 20.0% w/v and the wetting agent being present in the range of about
5 0.0001% to about 5.0% w/v.

10. A method for decontaminating using electrochemically activated (ECA) water to decontaminate articles or systems which contain materials susceptible to corrosion due to ECA water, further characterized by
5 adding at least one of corrosion inhibitors, wetting agents, and combinations thereof to ECA water.

11. The method of claim 10 further characterized by the corrosion inhibitor being added to the ECA system prior to electrochemical-activation of the water.

12. The method of either of claims 10 and 11 further characterized by electrochemically activating water to generate the ECA water followed by adding at least one of

- 20 -

either corrosion inhibitors, wetting agents, and
5 combinations thereof.

13. The method of any one of claims 10-12, further
characterized by the wetting agent being added to the ECA
water in an amount which reduces the surface tension of
the ECA water to provide for the penetration of the ECA
5 water into items coming into contact with said ECA water.

14. A method for enhancing penetration of
electrochemically activated (ECA) water into articles in
contact with the ECA water which comprises adding a
penetration enhancing effective amount of a wetting agent
to the ECA water.

15. The method of claim 14 which further comprises
adding a corrosion inhibitor to the ECA water.

16. A method for decontaminating medical equipment
by contacting said medical equipment with a disinfection
effective amount of a composition of any one of claims 1
through 9 wherein the medical equipment is contacted for
5 a period of time sufficient to disinfect the medical
equipment without corroding the medical equipment.

INTERNATIONAL SEARCH REPORT

Application No
PCT/US 98/25100

A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 C02F1/46 A61L2/18 C23F11/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 C02F A61L C23F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 096, no. 010, 31 October 1996 - & JP 08 164390 A (KONICA CORP; JAPAN ORGANO CO LTD), 25 June 1996 see abstract ---	1
X	WO 92 06040 A (GULDAGER ELECTROLYSE) 16 April 1992 see page 3, line 1-5; claim 1 ---	1
A	WO 97 19896 A (AUSTECH PTY LTD; BRIGGS WILLIAM ERNEST (AU); FISHER STAMP JOHN THO) 5 June 1997 see page 7, line 3-6; claim 1 ---	1, 10, 11
A	EP 0 761 235 A (KAIGEN CO LTD) 12 March 1997 see claim 1 ---	1, 10

-/-

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"Δ" document member of the same patent family

Date of the actual completion of the international search

25 March 1999

Date of mailing of the international search report

12/04/1999

Name and mailing address of the ISA
European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel: (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Torfs, F

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/US 98/25100

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 097, no. 012, 25 December 1997 & JP 09 201585 A (DAIKIN IND LTD), 5 August 1997 see abstract ---	1,10
A	PATENT ABSTRACTS OF JAPAN vol. 097, no. 011, 28 November 1997 & JP 09 173428 A (MITSUBISHI PLASTICS IND LTD), 8 July 1997 see abstract ---	1,10
A	PATENT ABSTRACTS OF JAPAN vol. 097, no. 003, 31 March 1997 & JP 08 308910 A (MIZU KK), 26 November 1996 see abstract ---	1,10
P,A	PATENT ABSTRACTS OF JAPAN vol. 098, no. 005, 30 April 1998 -& JP 10 024294 A (HOSHIZAKI ELECTRIC CO LTD), 27 January 1998 see abstract ---	1,10
A	US 5 236 600 A (HUTCHINS DANNY T) 17 August 1993 ---	
A	US 4 731 222 A (KRALOVIC RAYMOND C ET AL) 15 March 1988 -----	

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 98/25100

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9206040 A	16-04-1992	CA 2092421 A DK 148289 A EP 0550430 A	28-03-1992 29-09-1990 14-07-1992
WO 9719896 A	05-06-1997	AU 1185997 A CA 2226294 A CN 1202875 A EP 0876299 A NZ 324636 A	19-06-1997 05-06-1997 23-12-1998 11-11-1998 25-11-1998
EP 0761235 A	12-03-1997	JP 9108307 A CN 1149495 A	28-04-1997 14-05-1997
US 5236600 A	17-08-1993	NONE	
US 4731222 A	15-03-1988	AT 63222 T CA 1273774 A EP 0232170 A GR 3001926 T JP 1745511 C JP 4030865 B JP 62186860 A US 5391360 A US 5374394 A US 5407685 A US 5350563 A US 4892706 A US 5037623 A US 5552115 A US 5077008 A US 5116575 A US 5091343 A US 5217698 A US 5225160 A US 5209909 A	15-05-1991 11-09-1990 12-08-1987 23-11-1992 25-03-1993 22-05-1992 15-08-1987 21-02-1995 20-12-1994 18-04-1995 27-09-1994 09-01-1990 06-08-1991 03-09-1996 31-12-1991 26-05-1992 25-02-1992 08-06-1993 06-07-1993 11-05-1993